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Science 30 Information Bulletin

1996-97 School Year

Science 30 Information Bulletin

Diploma Examinations Program

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Students First!
Student Evaluation

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This document was written primarily for:

Students	✓
Teachers	✓ Science 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

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Purpose of the Bulletin

The purpose of this bulletin is to provide students and teachers of Science 30 with information about the diploma examinations scheduled for 1997.

We encourage teachers to share the contents of this bulletin with students and to review the scoring criteria with them.

If you have requests, questions, or comments about the contents of this bulletin, please contact:

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Important Dates in 1997

Administration of the Science 30 Diploma Examination

1997 Administrations	*Time**
Tuesday, January 28	1:00–3:30 P.M.
Wednesday, June 25	1:00–3:30 P.M
Friday, August 15	1:00–3:30 P.M

* The diploma examination is designed for a writing time of 2.5 h. Students may have an additional 0.5 h to complete the examination.

Please consult the *General Information Bulletin, Diploma Examinations Program*, for a complete schedule for all subject areas.

Scoring of the Examination

1997 Administrations	*Scoring Dates***
January	February 11 and 12 (Head Markers) February 13 to 15
June	July 5 and 6 (Head Markers) July 7 to 9
August	August 22

** Dates are tentative and will be confirmed by telephone with markers.

Notes of Interest

Information about Markers

The written-response questions of the Science 30 Diploma Examinations are marked by Science 30 teachers selected from those who have been recommended as markers to the Student Evaluation Branch by their superintendents. To qualify for recommendation, a teacher must have taught the complete Science 30 course twice, be teaching the course in the current school year, and have an Alberta or Northwest Territories Permanent Professional Teaching Certificate.

Often, more teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (experienced markers and first-time markers are included)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation)

Teachers who wish to be recommended as markers for the January 1997 examination should contact their superintendents by September 27, 1996. Teachers who wish to be recommended as markers for the June and August 1997 examinations should contact their superintendents by **February 28, 1997**.

Item Writing and Field Testing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. **Teachers who are interested in these activities should let their superintendents know by September 12, 1996.**

Reports

After each January and June administration of the Science 30 diploma examination, copies of the *Examiners' Report* for that particular administration are sent to teachers in all senior high schools in Alberta. The report contains provincial results along with comments about student performance on the examination. Examiners' reports are designed for teacher use. If we can make these reports more useful to you, please let us know.

School and Jurisdiction Statistical Reports are sent to each superintendent and senior high school principal after each January and June administration of the Science 30 diploma examination. These reports provide detailed information on how well the students in their school district and school, respectively, did on the Science 30 diploma examination. Teachers may use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Each year, the Student Evaluation Branch produces the *Annual Report, Diploma Examinations Program.* This report contains information about the results achieved by all students who wrote diploma examinations in the preceding school year. It also contains special studies on topics of interest. The first annual report (1989–90 school year) contains a study comparing achievement in various diploma courses. The second report (1990–91 school year) contains a study comparing the achievement of students who repeat diploma examination courses and rewrite diploma examinations with their achievement the first time and with the achievement of students who write only once. The third report (1991–92 school year) contains a study of participation rates in diploma examination courses. The fourth report (1992–93 school year) contains a study of English 30 students' application of conventions of language. The fifth report (1993–94 school year) presents a comparison of provincial participation rates in diploma examination subjects for the school years 1991–92, 1992–93, and 1993–94. The sixth report (1994–95 school year) examines declining enrollment of Grade 12 students. Each of these special studies will be of interest to teachers who are involved in interpreting diploma examinations results of their students.

Additional copies are available from the student Evaluation Branch.
Phone: 427-0010 FAX: 403-422-4200
To call toll-free from outside of Edmonton, dial 310-000.

As of the 1995-96 school year, this report is available on the Internet at Alberta Education's Web Site (http://ednet.edu.gov.ab.ca).

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff are available to provide inservices or presentations related to diploma examinations or the interpretation of diploma results.

Student Use of Scientific Calculators

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students. Students are expected to provide their own scientific calculators. For a science examination, all that is needed is a calculator capable of performing logrithmetic calculations.

Refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations.

Clarification

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations, in the *General Information Bulletin*. Students should know that notes stored in electronic devices may not be brought into the examination room. It is the student's responsibility to ensure there is no information stored in the calculator. Failure to do this is a breach of exam procedures and is considered cheating.

Data Resources for Students

The Science 30 diploma examination is accompanied by a separate data booklet. The data booklets do not have to be returned with the exam booklets and answer sheets. The data presented are generic for all of the Science 30 diploma exams provided during a school year; therefore, only some of the data are useful for any particular exam.

The data booklet is extensive and contains information useful to students in Science 10, 20, and 30. The intent is for students to develop the science literacy skills of finding information and using it properly. For the diploma examination, the booklet will be used to find the appropriate information and use it properly to solve simple, straightforward problems. The following is an example of a question that can be solved by applying information found in the data booklet.

A portable television is plugged into the cigarette lighter of a car. The car's battery supplies 12.0 V of electricity and the television offers a resistance of 6.00 Ω. What amperage will be drawn by the television?

The student must recognize that the problem deals with electricity. By using the table of contents, he or she can determine that information about electricity is located on page 3 of the data booklet. The appropriate formula can be applied, and the problem solved.

Students are expected to be able to use a data booklet of this size and format by the end of Science 30. If students use the booklet in Science 10 and 20, it will help them to become familiar with it.

The Science Data Booklet is available through the Learning Resources Distribution Centre (403-427-2767). The cost is $10.85/15 pack and the order number is 300418.

New

A September '96 edition of the data booklet is being produced. Minor changes are being made to pages 2 and 3. The only change that will make a difference to student answers is to the table "Activity Series (for 1.0 mol/L solution at 25°C)" on page 4. Here, the mercury and silver half-reactions have been switched. Also the cromium and zinc half-reactions have been switched.

Guide for Students

New

A publication written for students called *Students First: A Guide for Students Preparing to Write the Science 30 Diploma Examination* is available in each senior high school. See your principal or department head for the black line master. This publication contains suggestions for exam preparation and exam writing suggestions. The Student Evaluation Branch highly recommends that students and teachers examine this document early in the term to prepare for the Science 30 Examination. Parents will also find this to be a useful publication.

Student Requests for Rescores

Students may request a rescoring of their diploma examinations. Before applying for a rescoring, students should check their Diploma Examination Results Statement to find out the distribution of marks. The mark on the machine-scored questions is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Students who decide to have an examinaton resocred must ensure that their application is received before the deadline specified on the results statement. The fee for rescoring each examination is $26.75, which includes GST. If a diploma examination mark is increased by 5% or more as a result of rescoring, the fee is refunded.

Student Requests for Rewriting

Students may rewrite a diploma examination in any regularly scheduled administration. Students must apply to the Student Evaluation Branch by November 15, 1996, and April 15, 1997, to be eligible to write the January and June diploma examinations. The fee for rewriting each examination is $26.75, which includes GST. (For more details, see the *General Information Bulletin*.)

Science 30 Information

Objectives of the Course

Science 30 is intended for students who want to better understand the scientific principles behind the natural events they experience and the technology they use in their daily lives. Science 30 is an inquiry-based course requiring creativity and imagination. The course is designed for students who are preparing for academic post-secondary studies.

Students of Science 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of scientific concepts by their increased ability to apply these concepts to relevant situations. They have developed a unified view of the sciences and an awareness of the connections among them.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, in particular by the successful completion of Science 10 and Science 20. These courses develop knowledge and skills that are prerequisite to success in Science 30.

Standards

Students who achieve an *acceptable* standard of performance in Science 30 can state or solve multistep problems. They are able to correctly answer questions involving concepts from a particular area of science. These students are able to follow correct laboratory procedures when given specific directions. They can make the connection between science concepts and laboratory activities when the data are used to verify known information. Drawing a graph from experimental data or reading values from a graph does not present a problem for these students. They can use science knowledge to explain the operation of various technologies studied in Science 30. They are also able to present arguments about societal issues such as environmental concerns and ethical issues related to Science 30 material.

Students who achieve a standard of *excellence* in Science 30 have gained knowledge and abilities that allow them to be literate in a broad range of science areas. Such students can integrate concepts from many areas of science. They demonstrate creativity and flexibility and can solve multistep problems. They are able to design or refine laboratory procedures to demonstrate science principles or solve science problems. They can critically analyze scientific studies, including the associated charts, graphs, and conclusions. These students are aware of the variety of viewpoints relating to the environmental and ethical issues in the field of science and technology. They are able to clearly express their opinions about these issues.

Depth of Coverage

Some teachers have expressed concern about the amount of material that must be covered in the Science 30 course. Teachers who have taught the course state that once the depth of coverage is understood, they are successful in achieving full coverage of the program. The following are recommendations for the depth of coverage of the fifteen major concepts in the Science 30 Program of Studies. These recommendations were made by teacher committees working with members of the Curriculum Standards Branch and the Student Evaluation Branch.

Added to these recommendations are examples of questions that have proven difficult for students across the province but that may be tested in the future.

Unit 1 Major Concept 1

The structure and function of the circulatory system includes knowing the four chambers of the heart, where the valves are located, and how they work. Memorization of heart structures such as Purkinje fibers, SA node, and AV node is not necessary. A general understanding of the structure and function of the various types of blood vessels is required. The detailed naming of vessels as belonging to renal, hepatic, or mesenteric systems is not required. It is reasonable to expect students to know the pulmonary arteries and veins, aorta, vena cava, and coronary vessels. The pathway of the blood from the vena cava, through the heart, to the lungs, back to the heart, and out the aorta should be included. (Recommended time to complete core material: **six** hours.)

Unit 1 Major Concept 2

The structure and function of the body's defence mechanism includes the role of the skin as the first step in the defence process. Function, rather than detailed structure, of the skin is intended. The function of the cellular and non-cellular component of our immune system should not be dealt with in greater detail than the main events that are listed in the Program of Studies. Development of immunity or the failure to develop immunity and the role of vaccines is an important and current topic.

A working knowledge of blood types, while relating well with concept 4 in unit 1—genetics, is considered optional. (Recommended time to complete core material: **four** hours.)

Unit 1 Major Concept 3

The structure and function of the nervous system includes the organs of sight.

Memorization of the structures within these organs, such as sclera and fovea, is not necessary. It is reasonable to expect students to know the main features of the eye, such as retina, cornea, iris, optic nerve, pupil, rods, and cones. In describing the C.N.S. and P.N.S., a general description is all that is required for both its structure and function. The concept of negative feedback for the control of blood pressure ties this major concept with the section on circulation. Students should understand the significance of vasoconstriction and dilation but the role of baroreceptors goes beyond the depth required by the Program of Studies. **Note that cardiac function is controlled mainly by pressure changes and sympathetic and parasympathetic input, not by CO_2 and pH, as previously stated in the Program of Studies.**

Students should be able to describe the transmission of an impulse across a synapse in general terms; for example, they should be familiar with the concepts of polarization, all-or-none response, and neurotransmitters. **Note that the role of sodium and the generation of an action potential has been dropped from the Program of Studies.** (Recommended time to complete core material: **six** hours.)

Unit 1 Major Concept 4

The principles of heredity should be explained using simple Mendelian monohybrid crosses and their probabilities. Students should be aware of dihybrid crosses, but they are not expected to calculate probabilities. It is reasonable to expect students to predict genotypic and phenotypic ratios resulting from monohybrid crosses and to be able to use a pedigree chart.

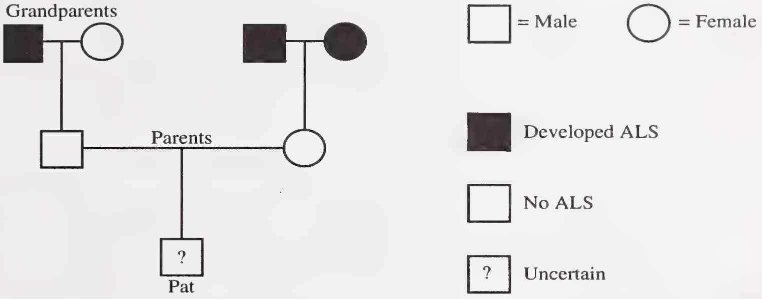
Memorization of the steps of mitoses and meiosis is not necessary, but a general description of the sequence of events in these processes is required. For example, students should know that chromosomes double, line up at the equator, and separate and pull to opposite poles. The same depth should apply to gametogenesis and fertilization. Use of the biological terms for structure and function is not required, but it is reasonable to expect students to use the terms haploid and diploid in their descriptions. Students should be able to make the connection between fertilization and Mendelian crosses (Punnett squares). The general characteristics of DNA structure and function should be understood. Base names such as guanine and uracil are not necessary, but the term nitrogen base is. A general description of the main events of replication (molecule unzips down the middle, new specific bases link, etc.) and protein synthesis is required, but the detailed naming of the steps in the processes (tRNA, ribosomes, mRNA, codons, etc.) is not required.

Note: The fourth concept mentions the importance of protein. If students do not know that proteins make up the structure of the cell and regulate the chemical reactions of the cell, they won't understand the role of DNA. (Recommended time to complete core material: **eight** hours.)

NEW

Use the following information to answer the next question.

Pat's family has a history of ALS (Lou Gehrig's Disease).
The following is Pat's family tree.



1. The gene for Louis Gehrig's Disease is

A. recessive
B. dominant
C. sex-linked
D. nondisjunctive

Unit 2 Major Concept 1

Solutions may have to be reviewed at the beginning of this unit (three hours). Most of the acid-base concepts, such as classification, indicators, buffers, and titrations, are covered in simple Brønsted-Lowry principles (proton transfer). Students are not expected to determine the strengths of an acid through the use of percent of dissociation or through Ka or Kb calculations. Percent dissociation has been removed from the data booklet.

Titration calculations involving monoprotic acids should be kept simple and related to solution stoichiometry as much as possible. Students are not required to generate or interpret titration graphs. Students should be able to determine the ranges of pH from the colour change in indicators. (Recommended time to complete core material: **nine** hours.)

NEW Students should be aware of the logarithmic nature of the pH scale

2. The pH of some snow is 5.5 and the pH of some pond water is 7.5. The $[H_3O^+_{(aq)}]$ has

A. increased by a factor of 2
B. decreased by a factor of 2
C. increased by a factor of 100
D. decreased by a factor of 100

Unit 2 Major Concept 2

The major topic of this concept is the impact of certain chemicals on our environment, from a local to global level. The main sources and effects of the listed pollutants should be understood. For example, over-fertilization of farmland leads to excess phosphates in lakes, which leads to increased algal growth and death of aquatic life. It is not necessary for the students to memorize a detailed series of chemical reactions to explain the cause and effect of certain air pollutants on our environment: simplified single-step chemical reaction equations are adequate. (Recommended time to complete core material: **eight** hours.)

NEW Students are expected to understand the basic water-quality test

3. An environmentalist expected a particular river's water to be high in organic content, which would cause a

A. low BOD and clear water
B. high BOD and clear water
C. low BOD and cloudy water
D. high BOD and cloudy water

Unit 2 Major Concept 3

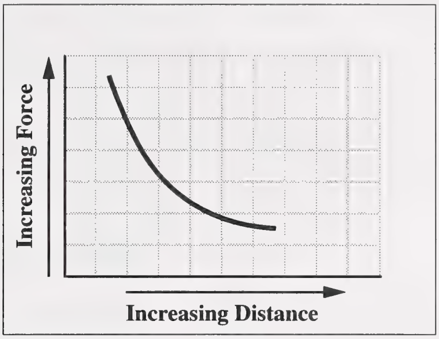
The organic chemistry nomenclature should be kept very simple and focus more on identification of the compound by its functional group (see data book) than on drawing and naming complex compounds. Structure, name, and use should be limited to the small, common members of each group. The pulp and paper process should be covered in terms of its environmental impact. It is not necessary for students to learn chemical reactions or the structure of these organic compounds. Pesticides should be covered in terms of the biomagnification aspect and their general characteristics, as listed in the second skill listed in the Program of Studies. (Recommended time to complete core material: **six** hours.)

NEW

Students should be familiar with chlorinated compounds such as dioxins, furans, CFCs, PCBs, and some pesticides.

Unit 3 Major Concept 1

The emphasis of this major concept is on general principles. Problems may be straightforward and able to be solved in a single step. Students should understand that the strength of a field is inversely proportional to the square of the distance. One way for students to visualize this concept is graphically, as shown below.



This relationship can be compared to concepts such as half-lives and population growth. (Recommended time to complete core material: **six** hours.)

NEW **Students are expected to use the data book to help them solve one-step problems.**

4. A space station orbited at a distance of 4.2×10^4 km from the centre of Earth. The gravitational field strength at this distance is

A. 2.3×10^{-1} N/kg
B. 9.5×10^{-1} N/kg
C. 2.3×10^{5} N/kg
D. 9.5×10^{5} N/kg

Unit 3 Major Concept 2

In this major concept dealing with electrical technology, students must know how to use the data book at a "science literate" level. Since there is not enough class time to practise all types and variations of questions, students must learn to determine what is required by the question, to identify what is given, and then to apply the appropriate formula.

NEW

Students may be required to solve simple two-step problems.

Numerical Response

1. A 100 W toaster and a 120 W frying pan are plugged into the same 110 V household circuit. Since they are connected in parallel, how much current will they draw?
Answer: ____________ .
(Record your answer to three digits on the answer sheet.)

Calculations involving circuits with complicated combination of series and parallel formations are not required. (Recommended time to complete core material: **nine** hours.)

Unit 3 Major Concept 3

Memorization of the various types of EMR is not necessary. This information is in the data booklet. Qualitative descriptions (fifth point in the Program of Studies) include knowing that EMR bends toward the normal when going from a substance with a lower index of refraction to one with a higher index of refraction. The greater the difference between the indices, the greater the amount of refraction. The application of trigonometry equations is not required. **Note: The ability to generate block diagrams of AM and FM communication has been dropped.** (Recommended time to complete core material: **five** hours.)

NEW

5. When Carol bends down to reach for a stone under water, her grasp of the stone is slightly displaced. This is because

A. light from the stone is refracted toward the normal in air
B. light from the stone is refracted away from the normal in air
C. polarized light from the water surface causes an apparent displacement of the stone's position
D. light from the stone is approaching the vertical angle for water to air, thus displacing the apparent position of the stone

Unit 3 Major Concept 4

The use of a spectroscope to analyze the composition of substances and the motion of stars is covered in this major concept, so a basic qualitative understanding of spectroscopy is necessary. A detailed knowledge of theories on the origin of the universe is not required. Students should know the basic principles of the Big Bang theory and how red shift provides evidence for this theory. The life cycle of stars, using the Hertzprung-Russell chart, is not required. (Recommended time to complete core material: **six** hours.)

Unit 4 Major Concept 1

Some teachers indicated that they dedicate very little time to this major concept as a separate component. They prefer to integrate it into the other major concepts. This is a background topic for the unit, providing the "why" for further study. Interpreting data in graphical and numerical form, as it pertains to energy consumption, is important. Understanding exponential growth, sustainability, and the global distribution of energy use and production requires knowledge of half-life and doubling time. The study of energy sources must include assessing environmental impact of their development. This topic provides an excellent opportunity for risk/benefit analysis. (Recommended time to complete core material: **four** hours.)

Unit 4 Major Concept 2

Current energy consumption primarily originates from the Sun. This includes wind, hydro, and photosynthetic (fossil fuels) power. Life depends on solar energy through respiration of photosynthetic products. Energy conversions should be compared qualitatively: fuel combustion, solar-thermal, biomass, photoelectric, hydro, wind. A clear understanding of energy transformations before end use is necessary to discuss efficiency comparisions. Using Hess's Law to calculate the H_f of an unknown goes beyond the intent of the Program of Studies. (Recommended time to complete core material: **seven** hours.)

NEW

The above paragraph has led some people to believe that calculations using Hesse's Law have been dropped from the program of studies. This is not the case.

Numerical Response

2. $C_3H_{9(g)} + 5\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$. The energy released when one mole of $C_3H_{8(g)}$ burns is ____________ KJ. (Record your answer to three digits on the answer sheet.)

Unit 4 Major Concept 3

Both fission and fusion reactions produce energy according to the mass/energy equivalency. Students should be able to use the formula $E = \Delta mc^2$ to calculate the amount of the energy available in nuclear reactions. Mass change should be given in kilograms and energy in Joules so that a simple application of the formula is used without adding conversions. Students should be able to find missing nucleons in nuclear reactions and predict the energy produced, given the reaction. Relative comparisions of the amount of energy involved in nuclear, chemical, and phase changes is expected. (Recommended time to complete core material: **seven** hours.)

NEW

Numerical Response

3. The total mass of the products in this equation is 3.10×10^{-28} kg less than that of the reactants. The amount of energy released by the reaction of each uranium atom is ____________ $\times 10^{-11}$ J. (Record your answer to three digits on the answer sheet.)

Unit 4 Major Concept 4

Gravitational fields can be a source of energy production through transformation of tidal energy. An understanding of tidal changes and the conditions necessary for transforming tidal energy is expected. (Recommended time to complete core material: **two** hours.)

Examination Specifications

The 1997 Science 30 diploma examinations are constructed to place the following approximate emphases on the Science 30 Course General Learner Expectations.

Knowledge The student can:	***Emphasis***
• show how the body maintains **equilibrium** with its environment through the interaction of the nervous, circulatory, and immune **systems** Unit 1, Major Concepts 1 to 3	15–20%
• show the role of DNA in maintaining **equilibrium** Unit 1, Major Concept 4	5–10%
• classify and describe **systems** (categories) of **matter** including acids, bases, and organic compounds based on their chemical characteristics and their impact on the environment Unit 2, Major Concepts 1 to 3	20–25%
• demonstrate a knowledge of the **diversity** (similarities and differences) in the properties of gravitational, electrical, and magnetic fields Unit 3, Major Concepts 1 and 2	10–15%
• demonstrate an understanding of the properties of the electromagnetic spectrum **(energy)**, including the use of these properties in studying the history and structure of the universe Unit 3, Major Concepts 3 and 4	10–15%
• demonstrate an understanding of the sources of usable energy and the environmental impacts of various **systems** (forms) of energy production and use Unit 4, Major Concepts 1 to 4	20–25%

Skills ***Emphasis***

The student can: 20–30%

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) ***Emphasis***

The student can: 20–30%

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to practical problems using scientific principles and theories, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society, and assess the ability of society to interact responsibly with the environment
- apply the skills and knowledge acquired in Science 30 to everyday life and to related and new concepts in post-secondary studies

Each Science 30 diploma examination is designed to reflect the *Science 30 course* general learner expectations (GLEs) outlined in the *Science 20–30 Program of Studies, Interim June 1995, for Senior High Schools.* The general learner expectations are expressed in more detail by the specific learner expectations, which are organized into four units. Some questions on each diploma exam will assess achievement of specific learner expectations. Some questions will be based on the integration of the specific learner expectations.

All examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess students' ability to integrate several GLEs. All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and /or STS connections.

Examination Design

The design of the 1997 Science 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	44	55
Numerical Response	12	15
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked together.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent*.

A particular context may be used for more than one multiple-choice question, one or more numerical-response questions, as well as for one written-response question.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet. Answers to the written-response questions are written right in the exam booklet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list, and determination of a sequence of events.

The written-response portion of each Science 30 diploma examination contains two contextual questions: one that is skill-based and one that is STS-based. These are both open-response questions and each has a value of 15 percent.

The skill-based question may present a synopsis of a research project. Pertinent data are provided in the form of graphs and/or tables. Another approach may be to have the student design a study that might be used to address a particular situation. This question requires students to demonstrate a variety of science process skills.

The STS-based question presents a problem that requires students to make connections between scientific concepts, technology, and/or social issues. Furthermore, an acceptable response will demonstrate good communication skills.

Scoring guides for the written-response questions are provided on pages 12 and 13 of the data booklet.

A Science 30 bulletin was written for the 1994–95 school year. Included in it is an example test and a detailed description of standards. If you do not have a copy of this bulletin in your school, you may request one from John Drader at the Student Evaluation Branch.

Assessment of Skills and STS Connections

Students' understanding of the concepts of science are measured by every question on the examinations. In addition, some questions measure the students' development of the skills and thinking processes associated with scientific inquiry. Some questions will measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Communication skills are assessed most directly in the teacher-scored questions. The open-response questions are marked holistically and include criteria for assessing communication skills along with criteria for the other components.

The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Two-Marker Scoring System

Each Science 30 Diploma Examination has two written-response questions, both of which are open-response questions. Students' answers are scored by teachers using a holistic scoring guide. The guide describes the characteristics of students' answers that correspond to one of five values: 0, 1, 2, 3, or 4. Each student's answer is scored independently by two teachers. The two scores are added together for a combined total sub-score out of 8.

If the two scores obtained by the two independent readings represent a difference of 2 or more scale categories on the guide, the scores are classified as *discrepant*. Student responses that have *discrepant* scores are read by a third reader. The third reader will assign a score that is within the limits established by the discrepant scores of the first two readers. This score will be multiplied by 2 for a total sub-score out of 8.

The sub-score out of 8 is then pro-rated out of 12. A summary of the calculations follows:

Reader 1 Score (X out of 4) + Reader 2 Score (X out of 4) = Sub-score (X out of 8)

Pro-rated Raw Score (X out of 12) = Sub-score (X out of 8) × 1.5

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Background

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted.

2. Students must clear calculators that are brought into diploma examinations of all information they have stored except for
   a. programs used for computing values of the formulas on the diploma examination data tear-out pages or in the data booklets,
   b. programs used for graphing quadratic relations as found in the Mathematics 30/33 Interim Teacher Resource Manual.

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
   a. all calculators operate in silent mode,
   b. students do not share calculators or information contained within them,
   c. calculator cases are stored on the floor throughout the exam, and
   d. all examination rules are followed.

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

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Revised 30 August 96

Appendix B

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Sciences Diploma Examinations

Significant Digits (measured values)

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   $$\begin{array}{rl} 12.3 & \text{(least precise)} \\ 0.12 & \\ \underline{12.34} & \\ 24.76 & \end{array}$$

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity in the original data with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24
   b. (1.23)(4.321) = 5.31483
   c. 5.31483/0.24 = 22.145125

      [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

   Note: In the example given, steps *a* and *b* yield interim values. These values should not be used in determining the number of significant digits.

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4. When calculations involve exact numbers (counted and defined values), the calculated answer should be rounded based upon the measured value(s). For example:

   12 eggs × 52.3 g/egg = 628 g

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix C

Directing Words

Discuss

The word “discuss” will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity

The following words are specific in meaning.

Compare

Examine the character or qualities of two things by providing characteristics of both that point out their mutual *similarities* and *differences*

Conclude

State a logical end based on reasoning and/or evidence

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures

Criticize

Point out the *merits* and *demerits* of an item or issue

Define

Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits

Describe

Give a written account or represent the characteristics of something by a figure, model, or picture

Design/Plan

Construct a plan, i.e., a detailed sequence of actions, for a specific purpose

Enumerate

Specify one by one or list in concise form and according to some order

Evaluate

Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages

Explain

Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail

How

Show in what manner or way, with what meaning

Hypothesize

Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically

Identify

Recognize and select as having the characteristics of something

Illustrate

Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram

Infer

Form a generalization from sample data; arrive at a conclusion by reasoning from evidence

Interpret

Tell the meaning of something; present information in a new form that adds meaning to the original data

Justify/Show How

Show reasons for or give facts that support a position

Outline

Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps

Predict

Tell in advance on the basis of empirical evidence and/or logic

Prove

Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons

Relate

Show logical or causal connection between things

Solve

Give a solution for a problem; i.e., explanation in words and/or numbers

Summarize

Give a brief account of the main points

Trace

Give a step-by-step description of the development

Why

Show the cause, reason, or purpose

Appendix D

Science Process Words

Hypothesis:	A single proposition intended as a possible explanation for an observed phenomenon; e.g., a possible cause for a specific effect
Conclusion:	A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence
Experiment:	A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations
Variables:	Conditions that can change in an experiment. Variables in experiments are categorized as: • *manipulated variables* (independent variables)—conditions that were deliberately changed by the experimenter • *controlled variables* (fixed or restrained variables) —conditions that could have changed but did not, because of the intervention of the experimenter • *responding variables* (dependent variables)—conditions that changed in response to the change in the manipulated variables
Technology:	The development of our understanding of science is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology includes both these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

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